Control of Movement Research Group

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Form:
- Every 2 weeks (1st and 3rd Monday at 12.00, bring lunch)
- Journal Club format
- Occasional presentations such as mock defenses
- 'The COMO reading list'

Function:
- Must not be a presentation.
- We choose a paper from the reading list
    - Should be relevant for our own research
    - Should be (relatively) new papers
    - Should be original papers
- A 'Discussion Leader' will steer the pdf, everyone reads
- During reading everyone thinks about
    - What do I like about this paper?
    - What do I not like about this paper?
    - What can we learn from their approach?
- Here is a list of good questions when reviewing a paper:

    1. What is the central question that is being addressed?

    2. Does addressing this question contribute in a significant way to the field?

    3. What is the hypothesis?

    4. How is the hypothesis being tested?

    5. Does the experiment adequately test the hypothesis?

    6. Are there alternative hypotheses?

    7. Does the experiment serve to distinguish among the hypotheses?

    8. What are the controls?

    9. What experimental method is used?

    10. Are there technical aspects that may limit the interpretation of results?

    11. What are the results?

    12. How do the authors interpret the results?

    13. Do you agree with this interpretation?

14. Do the results make a significant contribution to the field?
15. Is this paper appropriate for this journal?
16. If you were a reviewer, would you:

    a) reject the paper,

    b) recommend revisions (what would they be), or

    c) accept the paper as is

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Readinglist

Welcome to the COntrol of MOvement Reading List! We appreciate your input.

- Please add exciting new papers related to motor control
- We pick our journal club papers from these lists

Week 4 and 5

The COMO reading list

1. Furuya et al.,2025, Science rob

Surmounting the ceiling effect of motor expertise bynovel sensory experience with a hand exoskeleton

https://www.science.org/doi/epdf/10.1126/scirobotics.adn3802

Why should I read this paper?

This is cool stuff! The authors show that passive training by a hand exoskeleton at ‘’suprahuman’’ finger press velocities enhances subsequent piano performance in elite pianists.

2. Zang & Schöner 2024, JNP

Estimating descending activation patterns from EMG in fast and slow movements using a model of the stretch reflex

https://journals.physiology.org/doi/full/10.1152/JN.00449.2024

Why should I read this paper?

Why do we have reflexes? And how much is any movement driven by infomratipn from sensory afferents versus a descending drive (e.g. corticospinal)? Here the authors try to estimate this with an unloading paradigm.

3. Stenner et al. ,2025 Science

Prior knowledge changes initial sensory processing in the human spinal cord

https://www.science.org/doi/10.1126/sciadv.adl5602

Why should I read this paper?

Are you working with SSEPs? Or SAI? Here the authors do a very simple manipulation: Electrical stimulation of a peripheral nerve with fixed vs jittered interstimulus interval and look at direct and skin surface recordings from the spinal cord.

4. Nakayama et al. 2025 , Neurosci Res.

Premovement neuronal activity in the primary motor cortex is associated with the initiation of ipsilateral hand movements in monkeys

Why should I read this paper?

We all agree that the vast majority of corticospinal inputs to the spinal motoneurones and interneurons come from the contralateral hemisphere. A bulk of research has shown that the ipsilateral M1 is involved in some aspects of motor control and motor learning. Here the authors identify a subset of M1 neurons where premovement activity correlates with ipsilateral response times. Why do we not see ipsilateral MEPs when we do TMS?

5. Mooney et al., 2023, Brain Stimul

Mapping subcortical motor pathways in humans with startle-conditioned TMS

Why should I read this paper?

Well..here the authors try to establish a way to investigate non-corticospinal pathways using TMS. They evoked ipsilateral MEPs (only during strong contractions and with high intensities) and facilitate these with a startling acoustic stimulation. So it is possible..but is the parameter space in which the is possible to narrow to be relevant for studies of motor control? Is that the case for our i-TEPs?
NOT NEW NEW..but NEW'ish.

6. Hirano et al., 2025, JNeurosci

Enhanced somatosensory inhibition sharpens hans representation and sensorimotor skills in pianists.
https://www.jneurosci.org/content/jneuro/early/2025/01/01/JNEUROSCI.1486-24.2024.full.pdf
Why should I read this paper?
This paper shows how fine motor skills rely on the somatosensory system to process information from multiple body parts based on expert pianists. The present findings demonstrate that extensive musical training strengthens inhibitory processing in the somatosensory system, which underlies pianists' remarkable finger dexterity.

7. Alderink et al. 2025, bioengineering

Analysis of Connectivity in Electromyography Signals to Examine Neural Correlations in the Activation of Lower Leg Muscles for Postural Stability: A Pilot Study
https://www.mdpi.com/2306-5354/12/1/84
Why should I read this paper?
This study gives insight into the neural mechanism of postural control

8. Klassen et al., 2025, JNP

Spectral changes in motor thalamus field potentials during movement
https://journals.physiology.org/doi/full/10.1152/jn.00419.2024
Why should I read this paper?
They studied movement-associated spectral changes in human motor thalamus and observed focal increases in broadband power with movement. This biomarker may be used as a tool for intraoperative functional mapping, DBS targeting, and closed-loop device control.

9. Pawłowski et al., 2025, fnhum

Does muscle fatigue change motor synergies at different levels of neuromotor control?
https://www-frontiersin-org.mu.idm.oclc.org/journals/human-neuroscience/articles/10.3389/fnhum.2024.1519462/full
Why should I read this paper?
The study investugates how fatigue affects motor synergies at different levels of hierarchical motor control. It gives insights in how these levels interact - does fatigue disrupt synergy formation at the lower level, and does it eventually impact task performance at the higher level? Moreover, they test how different types of fatigue (static vs dynamic) affect this hierarchical

organization. If you are interested in how the CNS adapts to fatigue to preserve movement, this is really interesting.

10. Vassiliadis et al., 2020, JNP

Motor training strengthens corticospinal suppression during movement preparation
https://journals-physiology-org.mu.idm.oclc.org/doi/full/10.1152/jn.00378.2020

Why should I read this paper?

This study investigates an important aspect of motor learning, namely motor preparation. In particular they investigate preparatory suppression by using TMS. They show that as participants train to initiate movements more quickly, their preparatory suppression deepens, which may be counterintuitive as one may think that aster movements would require more excitation in the motor system before execution. Also found that resting CSE increased with training. However, the degree of training-related preparatory suppression predicted improvements in RT, while resting CSE did not. At a single trial level, the relation of RTs and preparatory suppression was also observed but only in the nonselected effector. Interesting insights in how the brain becomes more efficient in gating and releasing motor activity at the right time.

Week 6 and 7

COMO papers:

Nuyts, Beck et al., BioRxiv

Rostro-caudal TMS mapping of immediate transcranial evoked potentials reveals a pericentral crescendo-decrescendo pattern

https://www.biorxiv.org/content/10.1101/2025.02.14.638272v1

Wulf-Abramsson et al., 2025, Neuroimage

*Event-related theta synchronization over sensorimotor areas differs between younger and older adults and is related to bimanual motor contro*l

https://www-sciencedirect-com.ep.fjernadgang.kb.dk/science/article/pii/S1053811925000345

Why should I read this paper?
We often talk about the desynchronization before movement initiation. Here the authors show event related synchronization in the theta band before moving to a new force level. Can theta be used as the opposite of a beta bursts (‘ready to go’ vs ‘status quo’) *?*

Hendrix et al., 2025, JNEUROSCI

Parkinsonism disrupts neuronal modulation in the pre-supplementary motor area during movement preparation

https://www.jneurosci.org/content/early/2025/01/29/JNEUROSCI.1802-24.2025

Why should I read this paper?
PreSMA is an part of a motor network that is perturbed in PD. We target it with 1Hz rTMS to dampen subsequent development of dyskinesia (LID). Here the authors show that in non-human primates activity in a subset of neurons in preSMA is predictive of reaction time in goal oriented motor actions. But not in PD.

Corominas-Teruel et al., 2024, Biorxiv

Oscillatory impact of Transcranial Magnetic Stimulation at very weak-intensity on the primary motor cortex: A TMS-EEG study in the human brain

https://www.biorxiv.org/content/10.1101/2025.02.04.636500v1.abstract

Why should I read this paper?

Here, my vested interest in TMS may bias me a bit but there is a fundamental importance in understanding how little current/voltage it actually tackles to impact brain signalling. Can we talk about a TMS-analogue of the Arnold tongue principle where only frequencies natural to the targeted area can be entrained and only if TMS is delivered at the correct time of the ongoing signalling?

Kramer et al., 2025, Brain
On the use of sham transcutaneous spinal cord stimulation in spinal cord injury clinical trials
https://academic-oup-com.ep.fjernadgang.kb.dk/brain/advance-article/doi/10.1093/brain/awaf040/7997877?login=true&token=eyJhbGciOiJub25lIn0.eyJleHAiOjE3NDE3NzkxMTUsImp0aSI6ImFmY2RmNjI0LWY0MDItNGUzNy05MGY0LTI3MzgxYzQwMWE3ZCJ9.

Why should I read this paper?
Some neuromodulatory approaches to enhance motor recovery after lesions to the central nervous system are often studied in small populations. Unfortunately, that is often accompanied by an omission of a well controlled sham condition. In this comment, Kramer et al. discuss why this is not a great idea with a focus on transcutaneous spinal cord stimulation. The discussion is, however, valid for other neuromodulation modalities and central nervous targets as well.

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Kosuge et al., 2025, Brain Sci
Effects of Complex Movement on the Excitability of the Ipsilateral Primary Motor Cortex and Spinal Motoneurons Contralateral to the Movement: A Comparison of Ball Rotation and Grasping Tasks with Equivalent Muscle Activity
https://www.mdpi.com/2076-3425/15/2/171

Why should i read this paper?
Unilateral hand movements alter the excitability of the ipsilateral primary motor cortex and contralateral spinal motoneurons. Although this excitability increases during complex, high muscle-activity movements, few studies have examined the excitability of ipsi-M1 and contralateral spinal motoneurons during complex movements while accounting for muscle activity. This study investigated the excitability of ipsi-M1 and contralateral spinal motoneurons during complex and simple movement tasks with comparable muscle activity between the two tasks.

Wilken et al., 2025, Neuropsychologia
Beyond the neural underpinnings of action emulation in expert athletes: An EEG study

Why should i read this paper?
Athletes specializing in sports demanding rapid predictions and hand-eye coordination are highly trained in predicting the consequences of motor commands. This can be framed as highly efficient action emulation, but the neural underpinnings of this remain elusive. We examined the

neural processes linked to the training effect of athletes (4000 h of training) by employing a continuous pursuit tracking task and EEG data.

Hervault and Wessel, 2025, JN
Common and unique neurophysiological processes that support the stopping and revising of actions
https://www-jneurosci-org.mu.idm.oclc.org/content/early/2025/02/04/JNEUROSCI.1537-24.2025

Why should i read this paper?
This study gives insight into temporal dynamics of inhibitory control during action-stopping. By analyzing EEG, EMG, and corticospinal excitability, it investigates how different neurophysiological signatures relate to an initial broad “pause” phase, where motor activity is generally suppressed, and a later “retune” phase, where the brain selectively adjusts depending on whether the action needs to be completely stopped or modified.

Hendrix et al., 2025, JN
Parkinsonism disrupts neuronal modulation in the pre-supplementary motor area during movement preparation

https://www-jneurosci-org.mu.idm.oclc.org/content/early/2025/01/29/JNEUROSCI.1802-24.2025

https://www.biorxiv.org/content/10.1101/2024.10.22.619634v1
Why should i read this paper?
Pre-SMA has been implicated in the pathogenesis of motor disturbances found in parkinsonism, however changes in pre-SMA neuronal activity in the parkinsonian state during motor behavior have remained unclear. This study therefore investigates the neuronal activity during a “holding state” preceding cued movement in induced parkinsonism in nonhuman primates. Thereby it gives insights on on how parkinsonism impacts pre-SMA at a single-neuron level.

Thong et al., 2025, JN

Disinhibition across Secondary Motor Cortical Regions during Motor Sequence Learning: A TMS-EEG Study

https://www.jneurosci.org/content/45/8/e0443242024

Why should i read this paper?
So… here the authors study motor sequence learning i.e. the ability to chunk a sequence of finger presses resulting in fewer errors and faster reaction times. The stimulate over SMA during the planning phase and the measure resting state EEG as ‘learning’ progresses. The assess the aperiodic EEG and use the P25 from SMA stimulation to dive into SMA mechanisms. Let’s talk about it, but: when targeting SMA, what do you really excite? What is the P25? HOw to interpret the 1/f?

Week 10 and 11

Li et al. 2025, Brain Stim

Acute dentate nucleus deep brain stimulation modulates corticomotor excitability in chronic stroke survivors

https://www.brainstimjrnl.com/article/S1935-861X(25)00052-X/fulltext

Why?
In this paper, the authors follow-up on their previous publication relating to the effect of dentate nucleus DBS in stroke survivors., The authors use the active motor threshold to assess cortical excitability during DN stimulation.

Patil et al., 2025, Cureus
Comparative Analysis of Motor Preparation Using Bereitschaftspotential With Two Methods of Wrist Extension

https://assets.cureus.com/uploads/original_article/pdf/320525/20250222-414843-eiv13h.pdf
Why?
Motor control for voluntary movement involves the orchestrated activity of motor cortical areas, which activate approximately one to two seconds before movement onset. This preparatory neural activity, termed Bereitschaftspotential (BP), reflects the readiness of cortical circuits for initiating movement. BP has been linked to parameters such as force and rate of contraction; however, the influence of movement precision on BP components is less understood. This study aims to investigate how movement precision affects BP characteristics, providing insights into the neural dynamics underlying motor preparation.

Special Theme: neural activity in the motor cortex

Why a special theme reading list that is *hors piste* to all the guidelines we agreed on ?

I propose this extra reading list so we can bring each other up to speed on what ‘really goes on’ in the motor cortex. If any of these are suited for journal clubbing, I will add it to usual list.
I will add both some old seminal pers and a bunch of new papers that dig into this matter with advanced technique and from the shoulders of giants. In primates the direct connections from M1 to spinal motoneurons are highly suggestive of a role in movement execution. But across many species, movement kinematics are best predicted by neuronal and neural activity (i.e. single neuron and population) activity in the pre-movement phase preceding the movement much more than the transmission time from cortex to motoneuron.

Churchland & Shenoy 2024, Nat Neurosci

Preparatory activity and the expansive null-space

Why?
This recent paper does a very good job in introducing the idea of shifting our understanding of the nervous system from single neuron signals to population dynamics. This idea is build (in the motor system) on the notion that recurrent signals that do not directly contribute to the corticofugal output still shape the population dynamics. The paper includes a full page Glossary.

Contribution from Batista in Pittsburgh
Do I receive a small monthly contribution to my wine consumption from Aaron Batista to push his papers on you? This can neither be confirmed or denied, but notwithstanding, he and his group write papers on a conceptually and computationally tricky topic in a very understandable way.

Sadtler et al., 2014, Nature, *Neural constraints on learning*

https://www.nature.com/articles/nature13665

Why? Welcome to the ‘neural space’. There is a lot of neurons in the brain. And their activity can be combined in a lot of different ways. We typically say that there is a lot of redundancy in the system. But can neural activity be combined freely to generate actions?
Recording activity from many neurons generate a high-dimensional space i.e. neural space. These dimensions can be reduced down to 10 that constitutes an intrinsic manifold. BCI control of a cursor can be readily learned as long as the neural activity to movement transformation falls

within this intrinsic manifold, but not when it is outside. As such there is a computational limitations to how neuronal activity can be combined to control a cursor (or a limb?). But are these manifolds defined by micro-organization of networks?

Oby et al., 2019, PNAS, *New neural activity patterns emerge with long-term learning*
https://www.pnas.org/doi/epdf/10.1073/pnas.1820296116
Here the authors (Batista group) nuance the conclusion neural constrains and find that 'outside manifold perturbations' can be learned with prolonged training. Neural substrates?

Oby et al., 2025, Nat Neurosci *Dynamical constraints on neural population activity*

https://www.nature.com/articles/s41593-024-01845-7?utm_source=nature_etoc&utm_medium=email&utm_campaign=CONR_41593_AWA1_GL_DTEC_054CI_TOC-250207&utm_content=20250207#Bib1

Newest paper form the Batista group. Here they change the BCI transformation from velocity (the other two papers) to position. They use the temporal order of neural activity to make inferences on the constraints on neural redundancy. CAn activity in a give neural network accrue in any order? A complete and circular system would suggest so, but the hierarchy and receptive field specialization in e.g. visual cortex impedes this possibility. This paper has a nice introduction to the terminology.

Other:
Hennig et al., 2018, eLife, *Constraints on neural redundancy*
https://elifesciences.org/articles/36774#s3
Here the authors use BCi to investigate different theories relating to neural redundancy.

Week 12 and 13

Haverland et al., 2025, J Physiol

Human cortical high-gamma power scales with movement rate in healthy participants and stroke survivors

https://physoc.onlinelibrary.wiley.com/doi/10.1113/JP286873

Why?
Gamma is a prokinetic frequency. Here the authors find that peak gamme scales with movement rate in thump pressing test. Old folks are slower and have less gamma power.. Stroke survivors even more so. It is MEG so I am no expert on the methodological approach, but it seems to inform on a pretty straight forward prokinetci TMS protocol: gamma burst before and during movement?

Wadsley et al. 2025, J Phsyiol.
Goal-directed action preparation in humans entails a mixture of corticospinal neural computations
https://physoc.onlinelibrary.wiley.com/doi/10.1113/JP287939

Why?
This is interesting stuff! The authors find that during a wait period between a cue that informs on which hand to respond with the corticospinal gain is increased for that hand as measured with TMS. Conversely, corticospinal gain to the same muscle on the other hand as well as a irrelevant muscle is decreased. It appears that pre-movement gain in the corticospinal tract is regulated to suppress unwanted movement and promote goal-oriented movements. I wonder what happens with (i)TEPs?

Dernoncourt et al., 2025, JPhysiol

Flexible control of motor units: is the multidimensionality of motor unit manifolds a sufficient condition?

https://physoc.onlinelibrary.wiley.com/doi/10.1113/JP287857

Why?
In the end, motor control can be boiled down to spinal motor neurons (MNs' the final common pathway) being activated with an appropriate timing and to an appropriate extent. This is achieved in a collaborative manner, where afferent and descending inputs sum (in a non-linear fashion) to control the firing of the MNs. It is textbook knowledge that motoneuron are recruited

by Hennemanns principle (small to large, size referring to both the soma, axon, and the number and sizes of the muscle fibers innervated). However, some evidence indicate that MN recruitment is more flexible. Here the authors measure and model their way to the conclusion that it is actually pretty carved in stone. Nice.

Cheng et al., 2025, SpringerNature (Exp Brain Res)

The neural correlates of target and hand vision during movement planning and execution
https://link.springer.com/article/10.1007/s00221-025-07043-6

Why?
Their results indicate a sequential importance of seeing the target and the hand, prior-to and during the movement, respectively. This work provides neurophysiological evidence to better understand the utilization of vision of the hand and target during goal-directed reaching.

Chen et al., 2025, SpringNature (Neurosci Bulletin)

The supplementary motor area as a flexible hub mediating behavioral and neuroplastic changes in motor sequence learning: a TMS and TMS-EEG study.
https://link.springer.com/article/10.1007/s12264-025-01375-7

Why?
Attempts have been made to modulate motor sequence learning (MSL) through repetitive transcranial magnetic stimulation, targeting different sites within the sensorimotor network. However, the target with the optimum modulatory effect on neural plasticity associated with MSL remains unclarified. Our data demonstrated the role of SMAp stimulation in modulating neural communication to support MSL, which is achieved by facilitating regional activation and orchestrating neural coupling across distributed brain regions, particularly in interhemispheric connections. These findings may have important clinical implications, particularly for motor rehabilitation in populations such as post-stroke patients.

Distinct Modulations in Sensorimotor Postmovement and Foreperiod β-Band Activities Related to Error Salience Processing and Sensorimotor Adaptation

https://www.jneurosci.org/content/35/37/12753

Why?
Within motor cortical systems, beta oscillatory power has been linked to performance in visuomotor tasks. However, beta power is highly context dependent. In two EEG experiments

with human participants, β-activity was examined during the preparation of reaches immediately following perturbed movements. In the first experiment, both foreperiod and postmovement β-activities were shown to be parametrically modulated by the sizes of kinematic errors produced by unpredictable mechanical perturbations (force field), independent of their on-line corrections. In the second experiment, two types of reach errors were contrasted: movement-execution errors, which trigger trial-to-trial adaptive mechanisms, and goal errors, which do not elicit sensorimotor adaptation. Authors suggest that depending on the context, beta activity reflects different physiological processes. Findings may have important implications for brain-state dependent close loop targeting of the motor cortex based on β-oscillations.

Malone et al., 2025, npj science of learning
The control of movement gradually transitions from feedback control to feedforward adaptation throughout childhood

https://www.nature.com/articles/s41539-025-00304-7?utm_source=nature_etoc&utm_medium=email&utm_campaign=CONR_41539_AWA1_GL_DTEC_054CI_TOC-250326&utm_content=20250326

Why?
A strictly behavioral study. Some argue that chilædren and adults learn the same motor task through different neural processes favoring e.g. online vs offline learning (Beck et al., 2024). Here, Maone et al., investigates the ability of children to adapt to a visuomotor rotation (as a proxy for feed-forward, model-based learning). It appears that until they hit apex teen years, they are not very good at adapting. Let’s discuss. Both Bastian and Wolperts are defining characters for this field.

Papers from COMO group 2025

Nuyts, Beck et al., BioRxiv

Rostro-caudal TMS mapping of immediate transcranial evoked potentials reveals a pericentral crescendo-decrescendo pattern

https://www.biorxiv.org/content/10.1101/2025.02.14.638272v

Single and paired TMS pulses engage spatially distinct corticomotor representations in human pericentral cortex
Mads A.J. Madsen, Lasse Christiansen, Chloe Chung, Morten G. Jønsson, and Hartwig R. Siebner
Journal of Neurophysiology

Single and paired TMS pulses engage spatially distinct corticomotor representations in human pericentral cortex
Mads A.J. Madsen, Lasse Christiansen, Chloe Chung, Morten G. Jønsson, and Hartwig R. Siebner
Journal of Neurophysiology 0 0:0

Zeroual, M., Ginatempo, F., Loi, N., Vaira, L. A., Cano, A., Biglio, A., ... & Deriu, F. (2025). Sensorimotor integration and faces recognition in a model of altered face sensory information: neurophysiological study in patients with dentofacial deformities. *Clinical Neurophysiology*.

Week 14 and 15

Week 17 & 18

Dear All,
A few suggestions for some light post-Easter reading!

The sensory input from the external cuneate nucleus and central cervical nucleus to the cerebellum refines forelimb movements
Eneanya C, Smith GM
Cells 14:589

The sign of exploration during reward-based motor learning is not independent from trial to trial
Kooij K van der, Smeets JBJ, van Mastrigt NM, van Wijk BCM
Exp Brain Res 243:117

Transcranial magnetic stimulation over supramarginal gyrus stimulates primary motor cortex directly and impairs manual dexterity: Implications for TMS focality
Holmes NP, Di Chiaro NV, Crowe EM, Marson B, Göbel K, Gaigalas D, Jay T, Lockett AV, Powell ES, Zeni S, Reader AT
J Neurophysiol

Error signals in the parvocellular division of the red nucleus, not the magnocellular division, drive adaptation in reaching
Inoue M, Kitazawa S
Cell Rep 44:115598

Distinct synaptic plasticity rules operate across dendritic compartments in vivo during learning
Wright et al,., 2025 Science
https://www.science.org/doi/10.1126/science.ads4706

Week 23 & 24

UPPPPPP and running again! Summer is approaching and movements are on our minds!

Cerebellar Activity Affects Distal Cortical Physiology and Synaptic Plasticity in a Human Parietal–Motor Pathway Associated with Motor Actions

Goldenkoff et al. ,J Neurosci, 2025

https://www.jneurosci.org/content/45/23/e0404252025

Why?
Aside from the opening line of the abstract, this is a great paper. Every single brain stimulation based plasticity protocol known to man yields super variable after-effects. Part of this is due to the macro state of the targeted system. Here, Goldenkoff and coworkers use a facilitatory iTBS protocol delivered to the cerebellar cortex followed by a PAS protocol. They define their stimulation sites from rs-fMRI seeded in M1 (for the PPC site) and in the rs-defined PPC seed (for CB). well-thought out! Enjoy!

Plasticity reloaded: motor skill learning plus stimulation boosts adaptations in the ageing nervous system

Taube W

https://pubmed.ncbi.nlm.nih.gov/40434305/

Why?
A brief comment from Wofgang on the recent results from Jesper Lundbye-Jensen’s lab.

Graef et al., 2025, BioRxiv

Propagation of Beta bursts from the motor cortex to the motor units of multiple upper-limb muscles

https://www.biorxiv.org/content/10.1101/2025.05.22.655541v1.abstract

Why?
We provide the first evidence of cortical beta bursting in motor unit (MU) activity of forearm extensors across varying force levels. Our results show that MU beta bursting is time-locked to cortical beta bursts, supporting the idea of direct corticospinal transmission in the upper limb. Our findings highlight the value of MU level analysis in understanding beta burst transmission and indicate that burst timing is robust to changes in contraction levels. Unlike traditional bipolar EMG, MU-level analysis offers higher temporal precision and source specificity, enabling the reliable detection of beta bursts in individual muscles. These findings demonstrate a robust cortical-peripheral beta relationship during isometric contractions and reinforces the utility of HDsEMG for investigating burst dynamics and refining neurophysiological biomarkers.

Yordanove et al., 2025, SSRN

Effects of Preparatory Brain States on Motor Processing

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5266777

Why?
The aim of the present study was to assess the effects of motor target probability on the associations between pro-active motor preparation as reflected by slow negative potentials (SNPs), motor execution as reflected by response-related potentials (RRPs) and performance monitoring as reflected by correct response negativity (Nc).

Marques et al., 2025, SpringerNature Link

Dynamics of sensorimotor-related brain oscillations: EEG insights from healthy individual in varied upper limb movements conditions
https://link.springer.com/article/10.1007/s00221-025-07116-6

Why?
These findings underscore the variability in ERD/ERS patterns across different tasks and frequency bands, reinforcing the importance of further research into standardized analytical frameworks. By refining ERD/ERS analyses, our study contributes to developing reference frameworks that can enhance clinical and Brain-Computer Interface (BCI) applications.

Martel et al., 2025, iScience

Microendoscopic Calcium Imaging In Motor Cortices Of Macaques During Rest And Movement
https://www.cell.com/iscience/fulltext/S2589-0042(25)01028-4

Why?
I know it is not human.. But still sounds kinda cool. The study of motor cortices in non-human primates is relevant to our understanding of human motor control, both in healthy conditions and in movement disorders. Calcium imaging and miniature microscopes allow the study of multiple genetically identified neurons with excellent spatial resolution. We used this method to examine activity patterns of projection neurons in deep layers of the supplementary motor (SMA) and primary motor areas (M1) in four rhesus macaques. We implanted gradient index lenses and expressed GCaMP6f to image calcium transients while the animals were at rest or engaged in an arm reaching task. We tracked the activity of SMA and M1 neurons across conditions, examined cell pairs for synchronous activity, and assessed whether SMA and M1 neuronal activation followed specific sequential activation patterns. We demonstrate the value of *in vivo* calcium imaging for studying patterns of activity in groups of corticofugal neurons in SMA and M1.

Week 26

Qi et al.,m Nat Hum Behavior, 2025

Human motor cortex encodes complex handwriting through a sequence of stable neural states

Writing is tricky. Writing Chinese characters is even more tricky. In this paper, where neuronal activity is recorded in a single SCI patient during imagined writing during motor imagery, Qi et al find that motor cortical neurons shifts between states characterized by different directional tuning and gain.

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Special Issue on Cerebellum

Small brain - big plans

Dear Reader,

Reviews on the role of cerebellum

Cerebellar circuit computations for predictive motor control
Nguyen & Person 20525, Nat Rev Neuro

Consensus paper: roles of the cerebellum in motor control—the diversity of ideas on cerebellar involvement in movement."

Manto, Mario, et al. "*The Cerebellum* 11.2 (2012): 457-487.

Seminal papers on the role of cerebellum

Recent papers on the role of cerebellum

Dobrott et al., BIORXIVV

Corrective sub-movements link feedback to feedforward control in the cerebellum

https://www.biorxiv.org/content/10.1101/2025.08.01.668191v1.abstract

Nettekoven et al., 2025, J NEUROSCI

First application of a novel brain template: Motor training improves cortico-cerebellar connectivity in cerebellar ataxia

https://www-jneurosci-org.ep.fjernadgang.kb.dk/content/early/2025/07/31/JNEUROSCI.1823-24.2025

Summer 2025

What has been cooking in the realm of motor control over the summer?

Global motor system suppression as the primary mechanism of human action stopping: challenging the pause-then-cancel model

Chaudhuri et al., 2025, J neurosci

https://doi.org/10.1523/JNEUROSCI.0447-25.2025

TMS-based neurofeedback training of mental finger individuation induces neuroplastic changes in the sensorimotor system

Odermatt et al., 2025, J Neurosci

Motor sequence learning involves better prediction of the next action and optimization of movement trajectories

Kashefi et al., 2025, J Neurosci

Somatosensory cortex and body representation: Updating the motor system during a visuo-proprioceptive cue conflict

Mirdamadi et al., 2025, J Neurosci

The laminar pattern of proprioceptive activation in human primary motor cortex
Knudsen et al., 2025 Cereb Cortex
https://repository.ubn.ru.nl/bitstream/handle/2066/321395/321395.pdf?sequence=1

Van Roy et al., 2025, J Neurosci

Impaired online and enhanced offline motor sequence learning in individuals with Parkinson’s disease

https://doi.org/10.1523/JNEUROSCI.2193-24.2025

Sjøgård et al., 2025 J Neurosci

Increased sleep spindles in regions engaged during motor learning predict memory consolidation

https://doi.org/10.1523/JNEUROSCI.0381-25.2025

Griffa et al., 2025

Uncovering the role of the human hippocampus in procedural motor learning: Insights from implicit sensorimotor adaptation

https://doi.org/10.1523/JNEUROSCI.2119-24.2025

September 2025

Some of the exciting new september papers on motor control..and 1 that has nothing to do with motor control

Ding, Yidan, et al. "EEG-based brain-computer interface enables real-time robotic hand control at individual finger level." *Nature Communications* 16.1 (2025): 1-20.

Vargas-Irwin, Carlos E., et al. "Gesture encoding in human left precentral gyrus neuronal ensembles." *Communications Biology* 8.1 (2025): 1315.

Trach, Juliana E., Yiran Ou, and Samuel D. McDougle. "The human cerebellum encodes temporally sensitive reinforcement learning signals." *bioRxiv* (2025): 2025-09.

Amematsro, Elom A., et al. "Motor cortex flexibly deploys a high-dimensional repertoire of subskills." *bioRxiv* (2025): 2025-09.

Shingane, Somesh N., et al. "Task relevance selectively modulates sensorimotor adaptation in the presence of multiple prediction errors." *Journal of Neurophysiology* (2024).

van Loo, Karen MJ, et al. "What makes the human brain special-from cellular function to clinical translation." *Journal of Neurophysiology* (2025).

Morishita, Takuya, et al. "Complexity of neural outputs elicited by transcranial magnetic stimulation." *Journal of Neurophysiology* (2025).

Moll, Felix W., Julius Würzler, and Andreas Nieder. "Learned precision tool use in carrion crows." *Current Biology* (2025).

Yuasa, Akiko, et al. "Short-latency afferent inhibition on cortical motor representation in healthy humans." *Journal of Neurophysiology* 134.3 (2025): 866-874.

Han, Tao, Walter Paulus, and Ken Möhwald. "Posterior shifts of I-waves generated in tangentially oriented pyramidal cells of the motor cortex." *Journal of Neurophysiology* 134.3 (2025): 815-816.

Kase et al. : "A comparison of movement-related neuronal activities in cerebellar- and basal ganglia-recipient regions of the macaque thalamus" bioRxiv 2025.09.12.675921; doi: https://doi.org/10.1101/2025.09.12.675921

DRCMR papers:

Beck, Mikkel Malling, et al. "Not two sides of the same coin: Divergent effects of motor state on corticospinal and cortical responses to TMS of motor cortex." *bioRxiv* (2025): 2025-09.

Nuyts, Marten*, Beck, Mikkel Malling*,et al. "Rostro-caudal TMS mapping of immediate transcranial evoked potentials reveals a pericentral crescendo-decrescendo pattern", *NeuroImage* (2025),

https://www.sciencedirect.com/science/article/pii/S1053811925004495)

What is cooking in the realm of motor control?

October 2025

Romano, V., van Driessche, M., van Wingerden, N. *et al.* **Stage-dependent cerebrocerebellar communication during sensorimotor processing.** *Nat Commun* 16, 8812 (2025). https://doi.org/10.1038/s41467-025-64592-8

Haugland, J., Kirchhoff, M., Vetter, D., Ahola, O., Joob, A., Humaidan, D., Ziemann, U. , 2025, **"Fluctuations in the Optimal Sensorimotor Mu-Rhythm Phase Associated with High Corticospinal Excitability During TMS-EEG"** Brain Stimulation, ISSN 1935-861X, https://doi.org/10.1016/j.brs.2025.09.019

Sonia Turrini, Luca Tarasi, Naomi Bevacqua, Francesca Fiori, Sara Zago, Giorgio Arcara, Matteo Candidi, Vincenzo Romei, Alessio Avenanti, **"Disentangling the functional roles of premotor-motor pathways in automatic imitation: A combined network-based transcranial stimulation and drift diffusion modeling approach"**, Journal of Neuroscience 2 October 2025, e0340252025; DOI: 10.1523/JNEUROSCI.0340-25.2025

Tapas J Arakeri, Jean M Dill, Katalin M Gothard, Andrew J Fuglevand, "**Uncertainty Shapes Neural Dynamics in Motor Cortex During Reaching**", bioRxiv 2025.10.14.682390; doi: https://doi.org/10.1101/2025.10.14.682390

Carey, S., Balasubramaniam, R. **Postural control is destabilized by theta-burst stimulation over the DLPFC during the performance of a concurrent working memory task**. *Exp Brain Res* 243, 224 (2025). https://doi.org/10.1007/s00221-025-07150-4